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THE INTEGRATED DESIGN OF BUILDINGS ON INDUSTRY AREA, CASE STUDY FROM STRUCTURAL STATIC AND ENERGETIC STANDPOINTS

Abstract

Many buildings in industrial sites need frequently extensive reconstructions in order to meet structural static and energetic requirements that are in force now. For Ostrava, it is typical that the industrial sites are located next to the centre and residential areas of the city. Often, they diffuse into each other. Revitalisation of the site is addressed in the Municipal s Development Programme. Successfully revitalised buildings are an example of the said approach.

1 INTRODUCTION

Many buildings in industrial sites throughout the region of Ostrava are dilapidated and abandoned after closedown of production and industrial plants. The dilapidating industrial sites and industrial buildings in the city have often an negative impact on the general image of the city. In Ostrava, the industrial sites are often located next to the centre and residential areas of the city.

Issues relating to the industrial sites and definition of a concept for new utilisation of buildings and industrial sites are dealt with in Development Programmes drafted by the Municipality and Regional Authority.

Many technical, economic and social aspects should be taken into account when dealing with the buildings in industrial sites. Since this topic is very extensive, this paper will focus on improvements of building-energy parameters of the buildings and demolition works. Those aspects will be documents for two cases from the Ostrava Region.

Most buildings in industrial sites are precast reinforced concrete structures or cast-in-place structures with light-weight external cladding. According to the legislative that is in force now, the buildings do not meet requirements set forth in the building-energy concept and in the near future it will be essential to make major changes in the construction so that to protect the buildings and extend their service lives. In order to improve the architectural, structural and energy aspects of the building, the frequent solution has become recently demolition of several top floors (if the building on the industrial site is not demolished totally or if overall reconstruction would be too costly). Demolition works do not represent a total destruction of the building or its part, but become a thoughtful and mild process and aim-oriented activity.

2 METHODS AND CONCEPTUAL APPROACH TO BUILDINGS IN INDUSTRIAL SITES

In practice, there is not any proven methodology for the determination of future use of buildings in industrial sites that could be used in the comprehensive system of care in respect of such buildings. No standards stipulate methods used for the documenting of results of the building/technical survey and other necessary investigation of the site concerned. Each team of experts may choose the way of processing of results and information about the industrial site or building.

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Case studies have been drafted and certain experience has been gained in evaluation of the buildings [1]. The methodical and conceptual approach to the buildings that will have new functions in the regenerated industrial sites consists typically of following steps:

- the general analysis of the building, evaluating of the current building-technical condition of the building, and definition of a new concept based on requirements and demands submitted by a potential investor
- the energy and technical/operational analysis of the new function of the building in the industrial site in the future.
- the analysis of the industrial site, paying particular attention to impacts on the regenerated buildings (in particular, disappearing influence from undermined territories or presence of methane – those influences should be taken into consideration when evaluating the building, specifically when evaluating structural static aspects) and to remediation works in contaminated sites.
- the proposal of a remediation project for the building and for the site

To sum it up, the process covers three basic areas:

1. the revitalisation of the building itself
2. the revitalisation of the site
3. as well as social, cultural, ecological and environment influences

This paper will deal with 1) only, this means with the revitalisations and reconstructions of buildings in industrial sites.

Considering characteristics of industrial sites in the Ostrava Region, the buildings can be divided into:

- dwelling buildings and community services buildings. These buildings will not change their functions and are not covered by new functions of regenerated industrial sites. But actions should be taken in order to meet requirements of the energy legislative that is in force now. Furthermore, these buildings are located in territories with disappearing undermining influences or are located out of reach of underground mining effects.
- administrative, office, operation and manufacturing buildings. They are located in industrial sites and are covered by new functions of regenerated industrial sites. In all probability, they will be influenced by negative impacts typical of the site. Actions should be taken in order to meet requirements of the energy legislative that is in force now. Static protection actions will be essential in order to extend the service lives and architectural appearance of the buildings.

3 CASE STUDIES

The case studies will document the situation of the buildings in the industrial sites. The first building is located in Ostrava-Přívoz. In past, there was an underground mine and coking plant. The industrial site is very close to housing development. Railway lines, tram lines and all utilities and energies are near the site. New future functions have been planned for many buildings on the site. From the structural and static point of view, the condition of the buildings is rather good. They were preserved in the 1980s and 1990s. From the point of view of the energy concept, the revitalisation of the buildings would be rather complicated. A new owner (investor) of the building intends to have the building reconstructed so that it would meet requirements for the housing as well as for administration.

The second building is an administrative building that is located close to the centre of Ostrava. The investor required that the building should be reconstructed in order to improve the building-energy parameters as well as to improve the static and structural condition. A particular attention should be paid to the architectural expression of the building.

3.1 Case study No. 1 - administrative and office building in the former Odra Coal Mine in Ostrava-Přívoz (original purpose)

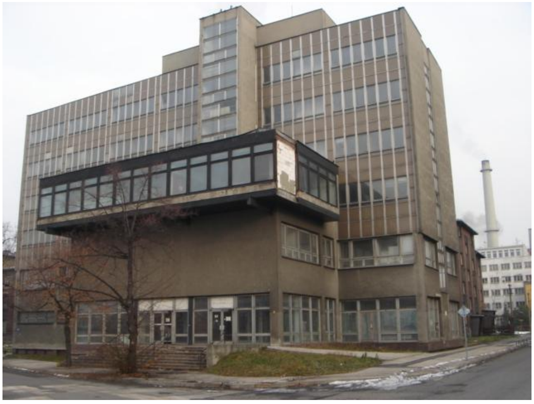

Fig. 1: Administrative and office building – the current situation

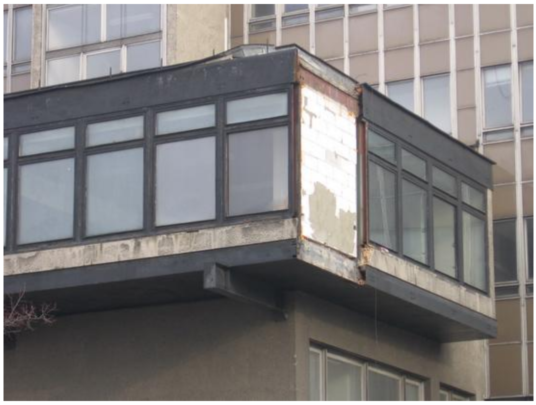

Fig. 2: Details of the facade on the administrative and office buildings ("Boletice" panels, steel skeleton, and metal windows)

In accordance with requirements set forth in [3], individual building structures in the building were evaluated from the point of view of thermal and technical assessment. The existing thermal parameters of the structure do not meet standard requirements [3]. Example: The heat transmission coefficient of ceramic panels in the building is $U = 1{,}64\ W \cdot m^{-2} \cdot K^{-1}$ and that of the light-weight external cladding from "Boletice" panels is $U = 1{,}07\ W \cdot m^{-2} \cdot K^{-1}$. These values are much higher than standard requirements ($U = 0{,}38\ W \cdot m^{-2} K^{-1}$).

Two alternatives have been proposed in order to improve energy parameters of the cladding structure. For details see [1]. The energy assessment has been carried out in accordance with the legislative in force. Some results are presented in Table 1. Reconstruction costs are about 100 CZK. Only the costs spent for improvements of the thermal parameters of the external cladding are from 18 to 25 million CZK.

Table 1. Some building-energy concept parameters pursuant to [1]

	Original condition	Alternative 1	Alternative 2	Note
Sum of heat losses of the building	378,125 [kW]	193, 906 [kW]	169,313 [kW]	
	STN [%]	U_{em} [$Wm^{-2}K^{-1}$]	Required U_{em} [$Wm^{-2}K^{-1}$]	Compliance with the requirement $U_{em} > U_{em,N}$
Original condition	290,0	2,28	0,79	-
Alternative 1	104,0	0,82	0,79	-
Alternative 2	79,0	0,62	0,79	compliant

3.2 Case study No. 2 – administrative and office building of former Severomoravské plynárny (North-Moravian Gasworks) in Ostrava

An example of a successful reconstruction and modernisation of an unsatisfactory building is the administrative building of former Severomoravské plynárny (Severomoravská plynárenská a.s.). The building did not meet requirements from the point of view of aesthetics, operational layout, and thermal-technical parameters. Demolitions works were a part of general capital repair, reconstruction, and additional construction of one of dominants in Ostrava [7].

The original building had 15 floors (plus the 16th floor as an additional storey with a boiler room in the roof). It was built in the 1970s. The external cladding was from light-weight metal and plastic with metal windows. From the static point of view, the building consisted of four longitudinal cast-in-place reinforced-concrete frames that created a three corridor structure. Ceilings were from prefabricated panels. Static load capacity of all structures was sufficient with a certain reserve for an extra load [6]. The reconstruction and modernisation did not change the function of the building [5] and effective loadings of the floors remained same [4]. What was special in the project was that two upper floors (the 14th and 15th floors) and the additional storey in the level of the 16th floor) were demolished in order to create a balanced appearance of the building in line with requirements. The demolished floors were replaced with a new steel structure of new floors. The structure is advanced, fresh and attractive from the architectural point of view.

Fig. 3: Administrative and office building of former SMP - the original situation

Fig. 4: Model – the designed building with the same total height

Demolition works are often carried out during reconstructions, modernisations and adaptations of buildings. The demolition can be partial or complete. It is always difficult to demolish load-carrying structures. If the structure is made from reinforced concrete or pre-stressed concrete, a special technology procedure as well as occupational safety and health protection requirements must be followed. The best demolition method and working procedure always depends on conditions of a specific building, on associated buildings, buildings in the neighbourhood, roads and pavements, utilities and energies, and on other aspects. Last but not least, the choice depends also on knowledge and expertise of a designer and technology capabilities of a building contractor. The demolition works become thus an untypical building activity where a kind of “prefabrication” that is known in the panel building industry can be used to a little extent only.

In past, demolition wastes such as bricks, stone, wood or steel were re-used often.

If heavy construction equipment or blasting is used for demolition, the building wastes are more damaged and re-use is possible to a limited extent only. The only exception might be concrete structures where the debris are crushed in a recycling crusher and “aggregates” are used as sub-base for roads and pavements. Demolitions of non-bearing structures and other infillings is not generally too complicated.

A detailed technology procedure was set for the demolition of load carrying structures and non-bearing structures. Very strict occupational health rules were followed because the works were carried out on the roof of the building and static damage was unacceptable. In case of rain, the water should not get to lower floors. On the site, several contractors worked at the same time and it was necessary to organise building activities of several independent work groups working under each other.

The technology progress of demolition works was supervised continuously each day both from the point of view of the occupational safety and from the point of view of static aspects. The ceilings should not be overloaded with debris and big parts of construction should not fall down, since they could damage or break through components that should not be demolished.

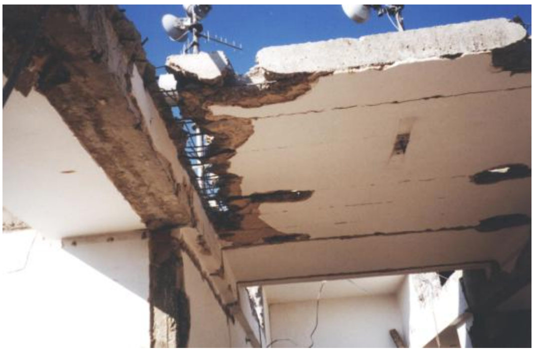

Fig. 5: PZD board ceilings in the additional storey on the roof were released from support faces

Fig. 6: All load carrying components (such as ceiling panels and girders) were drilled off in support faces. It was not possible to use another demolition method.

The technology procedure specified details for supporting, fastening, and suspending of the structure. A site supervisor adjusted flexibly the progress of works depending on the current situation. When drafting the technology procedure it was believed that it will be possible to disassemble the fabricated column skeleton with girders and panel ceiling in a reverse order than used for assembly. It was found out however that the cast-in-site filling is absolutely inseparable and the structure was really a perfect monolith. Consequently, it was not possible to demolish and release the elements from supports.

$$q^{\mathrm{r}}_{\mathrm{p\mathring{u}v}} = q^{\mathrm{r}}_{\mathrm{new}} \quad [5] \qquad \Rightarrow \text{---compliant---} \quad l_{new} < l_{p\mathring{u}v}$$

$$M^{r}_{p\mathring{u}v} = \frac{1}{8} \cdot q^{r}_{p\mathring{u}v} \cdot l^{2}_{p\mathring{u}v} > \frac{1}{8} \cdot q^{r}_{new} \cdot l^{2}_{new} = M^{r}_{new} \qquad \Rightarrow \text{---compliant---}$$

Because of the height of the building, it was not feasible to use hydraulic shears.

Fig. 7: After demolition of the 14th and 15th floors, the structure of the staircase remained.

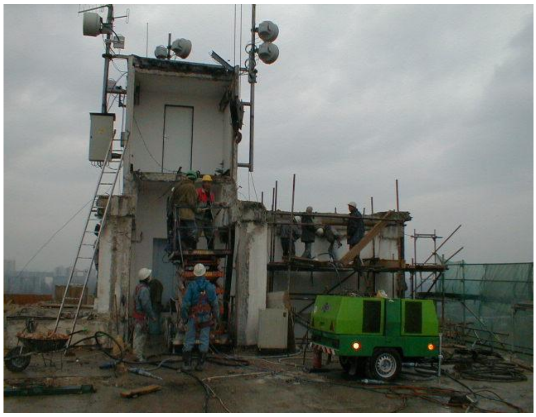

Fig. 8: A condition was (after demolition of the 14th and 15th floors) to keep the elevator shaft as well as aerials of mobile phone operators and automated control systems operated by Severomoravská plynárenská a.s.

Consequently it was decided to drill out horizontal components (the floor girders and ceiling panels) close to fastening points (in the support face). It was of course necessary to suspend the element in such a way so that the static parameters could be maintained.

When removing the structure, a continuous or interrupted gap is created and the bigger element is removed from the remaining structure. In case of generally big volumes and weights, the element is divided into two or more rather small elements. A saw, demolition hammer, or drill hammer can be used to create a separating gap. Or it is possible to drill a row of holes (this was the case in the example above) very close to each other. In order to separate the structure easily, special hydraulic presses can be inserted into the gaps. This is used for reinforced structures mainly because it is rather easy to interrupt the reinforcement in the gap , unless drilled out earlier.

Fig. 9: Isolated columns were suspended and separated in the footing with a pneumatic hammer. the reinforcement was separated with a flame.

Fig. 10: The girder was drilled out to the core in the column face under the girder.

3 CONCLUSION

The objective of all energy actions and building-energy concept is to decrease energy demands of the building. When rehabilitating and reconstructing industrial buildings, a particular attention should be paid to those components that are most important for the energy performance of the building. On top of this, the rehabilitation should be efficient in terms of costs spent.

Demolition works represent a specific and interesting industry. They play an important role among building professions, and the importance will increase in the future. The demolition works are rather unique and specific and a customised solution is essential. Even when demolishing identical buildings, external conditions and situation may change and the demolition works will be unique away.

The demolition works in the building industry and, in particular, in the concrete building industry will increase because of panel buildings. We are convinced that a particular attention will be paid to this profession in the future.

The subject of the demolition is not just to "break down" a house but to master technical aspects of the work, spend costs economically, and finish the life of the structure in a "decent" way.

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